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GB 1584131 A GB 1566152 A US 4584347 A
US 4242368 A US 4217852 A

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(54) Abstract Title
Improved continuous rotary extrusion machine

(57) A continuous rotary extrusion machine comprises a rotatable wheel (1), and a die assembly (8). The wheel has a principal endless groove (3) and secondary endless grooves (5) extending around its periphery (2). The machine also comprising non-rotatable abutments (4) extending into said grooves. The abutments (4) and the grooves (3, 5) define passages through which feedstock (30, 40) may be directed into said die assembly (8) for extrusion. The die assembly (8) causes the feedstock (30) from the principal groove (3) to be extruded as a core and the feedstock (40) from the secondary grooves (5) to be extruded as a cladding on said core.

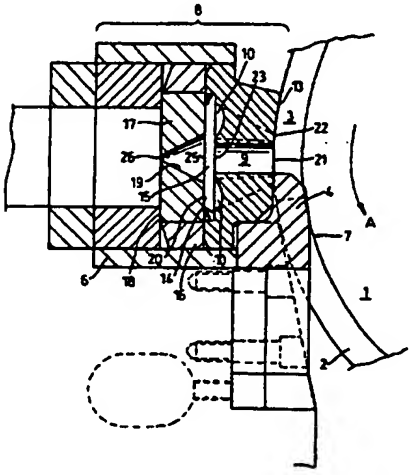

Fig. 1

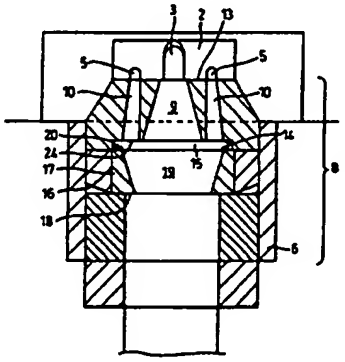

Fig. 2

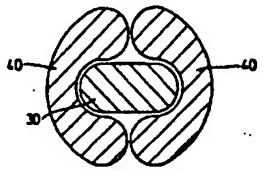

Fig. 4

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

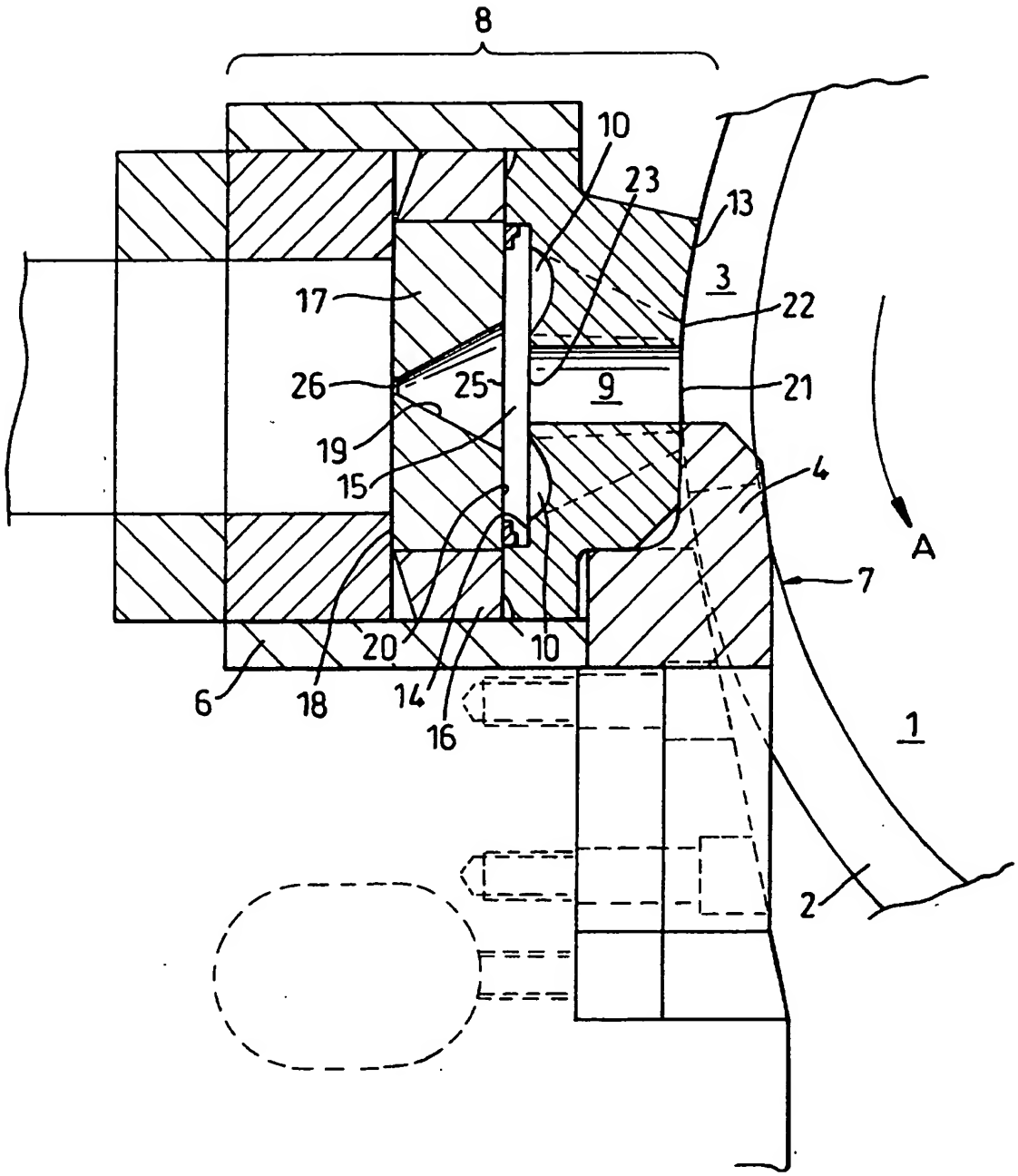

Fig. 1

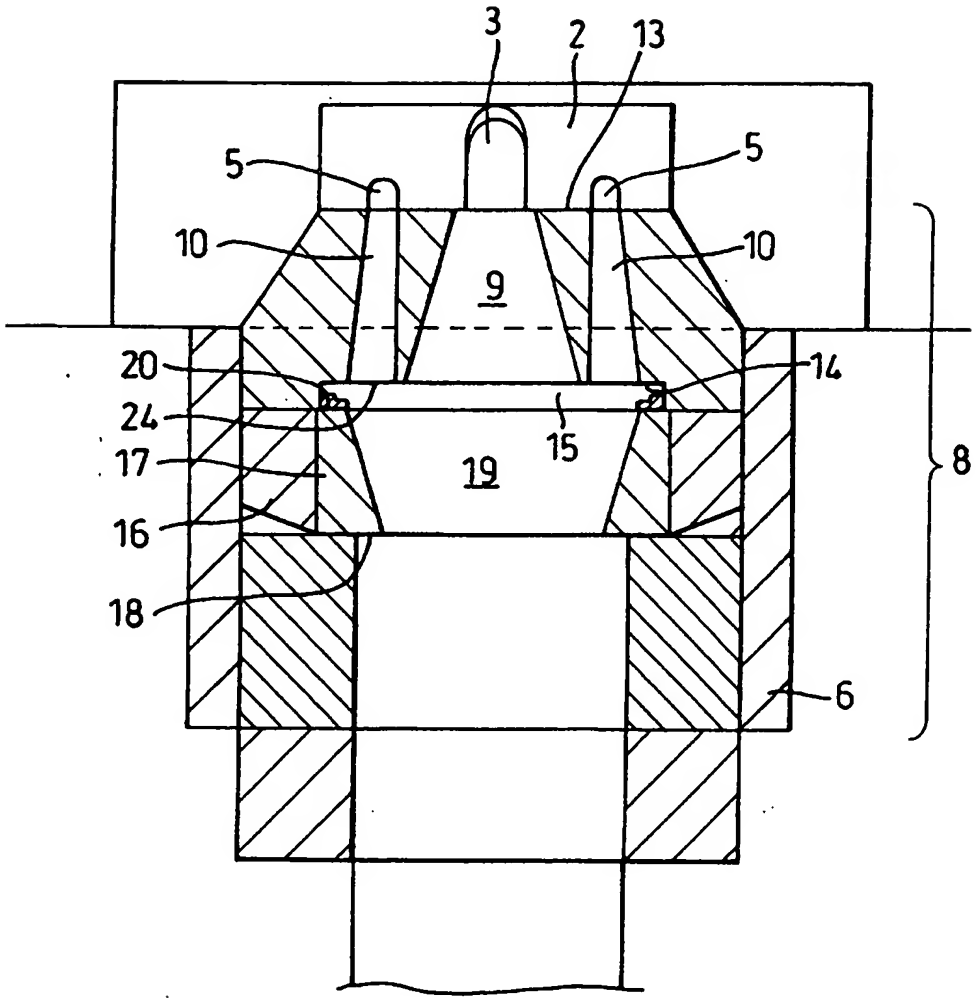

Fig. 2

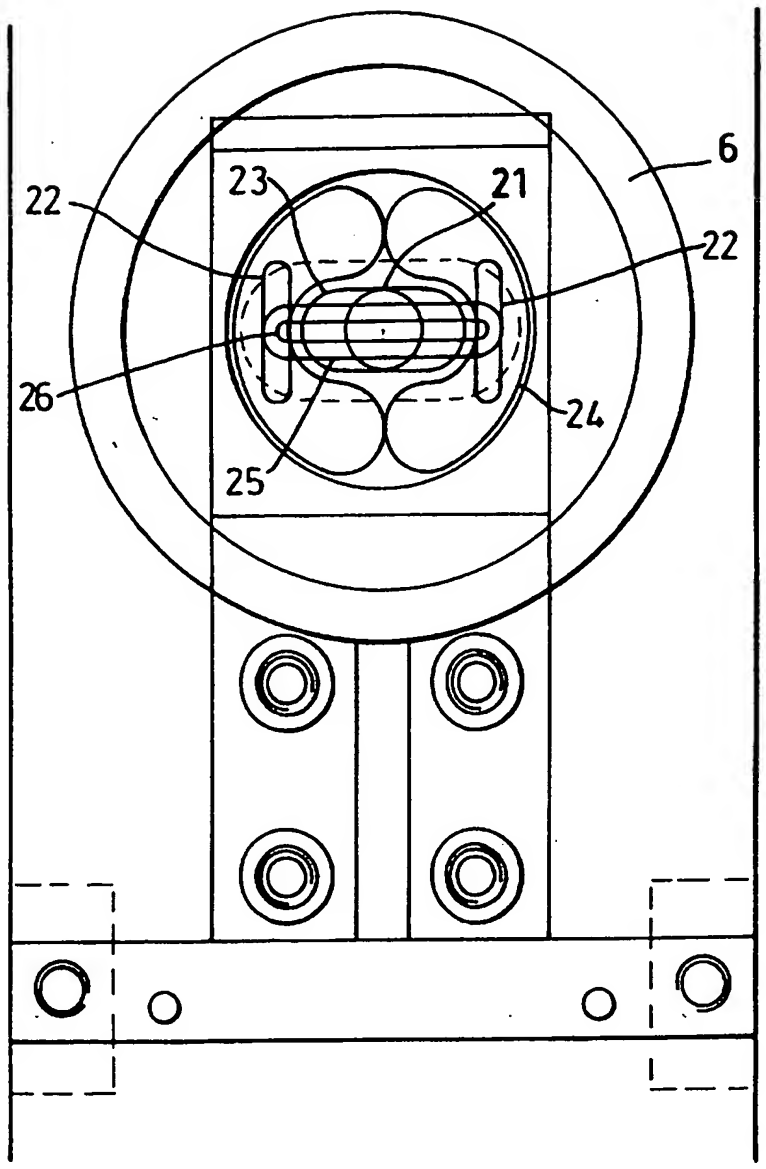

Fig. 3

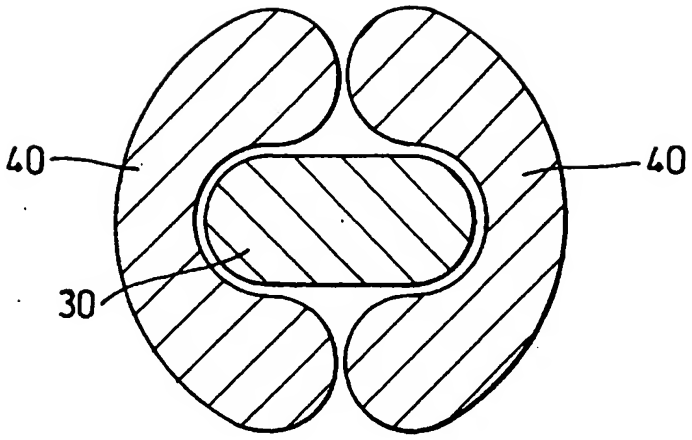

Fig. 4

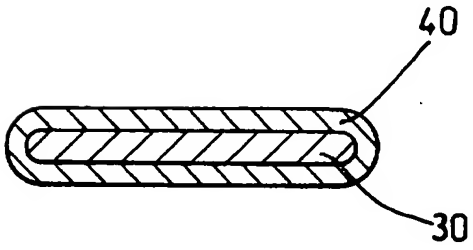

Fig. 5

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IMPROVED CONTINUOUS ROTARY EXTRUSION MACHINE

This invention is concerned with an improved continuous rotary extrusion machine.

Known continuous rotary extrusion machines can be used to produce extruded profiles of a predetermined cross-section. Such a machine typically comprises a rotatable wheel, and a die assembly. The wheel has an endless groove around its periphery and a non-rotatable abutment extends into said groove. The abutment and the endless groove define a passage through which a feedstock may be directed into said die assembly for extrusion. The material extruded by such a machine is typically a metal or an alloy but other materials such as composites are also possible.

It is known from US 5,000,025 to form a cladding directly about a preformed core using a two-wheel continuous rotary extrusion machine. Two oppositely disposed grooved wheels, each provided with an associated abutment, each provide a passage through which feedstock is fed to a common mixing chamber. A preformed continuous rod is fed into the mixing chamber. The rod is clad with the feedstock and emerges from the mixing chamber through a die as a single extrusion, the feedstock from the two grooves having blended together. GB 1,566,152 provides another example of cladding a preformed core with a feedstock extruded by continuous rotary extrusion machine. EP 0,398,747 A, US 5,359,874 and US 4,564,347 disclose continuous rotary extrusion machines having wheels with more than one groove to which the same feedstock is fed to produce a tubular extrusion.

It is an object of the present invention to provide a continuous rotary extrusion machine which enables a clad extruded core to be formed.

The invention provides a continuous rotary extrusion machine comprising a rotatable wheel, and a die assembly, said wheel having a principal endless groove around its periphery, the machine also comprising a non-rotatable abutment extending into said groove, said abutment and said endless principal groove defining a principal passage through which a first feedstock may be directed into said die assembly for extrusion, wherein said wheel is provided with secondary endless grooves extending around its periphery, and the machine comprises non-rotatable abutments extending into said secondary grooves, said abutments and said secondary grooves defining secondary passages through which a second feedstock may be directed into said die assembly for extrusion about the first feedstock.

A machine according to the invention allows a single wheel to be used for concurrent forming of a core and a cladding on the core. Thus, for example, core materials which have inconvenient, awkward or troublesome properties, such as brittleness, corrosive properties or abrasive properties, can be clad before the core needs to be handled.

Preferably, in a machine according to the invention, at least one of said secondary grooves is disposed on each side of said primary groove. This arrangement assists in achieving uniform cladding. The secondary grooves are, preferably, each of smaller cross-sectional area than the primary groove. The grooves may have transverse cross-sections which are U-shaped or trapezoidal but other shapes are possible.

Preferably, the die assembly of a machine according to the invention comprises a first die subassembly and a second die subassembly, the first and the second subassemblies cooperating in defining a mixing chamber, the first subassembly defining a primary passage extending between an aperture which communicates with the principal groove in the wheel and an aperture which communicates with said mixing chamber, the first subassembly also defining two secondary passages each of which extends between an aperture which communicates with one of the secondary grooves in the wheel and an aperture which communicates with said mixing chamber, the second subassembly defining a passage which extends between an aperture which communicates with said mixing chamber and an extrusion orifice of the machine.

The invention also provides a method of manufacturing a clad member using a machine according to the invention, the method comprising simultaneously feeding a first feedstock to the principal groove of the wheel of the machine and a second feedstock to each of the secondary grooves of said wheel, and simultaneously extruding the first feedstock as a core, and the second feedstock as a cladding on said core.

There now follows a detailed description, to be read with reference to the accompanying drawings, of an illustrative continuous rotary extrusion machine according to the present invention.

In the drawings:

Figure 1 is a longitudinal vertical cross-sectional view of a portion of the illustrative continuous rotary extrusion machine;

Figure 2 is a transverse horizontal cross-sectional view of the portion of the illustrative machine shown in Figure 1;

Figure 3 is an end view of the portion of the illustrative machine shown in Figures 1 and 2;

Figure 4 shows in transverse cross-section feedstocks as they enter a mixing chamber of the illustrative machine; and

Figure 5 shows in transverse cross-section a product of the illustrative machine.

A portion of the illustrative continuous rotary extrusion machine is shown in Figures 1, 2 and 3. The machine comprises a wheel 1 (part of which is shown in Figure 1). The wheel 1 is rotatable about a horizontal axis (not shown), in the direction shown by the arrow A. The wheel 1 is provided with a principal endless groove 3 extending around the periphery 2 of the wheel. The wheel 1 is also provided with two secondary endless grooves 5 extending around the periphery of the wheel 1. The grooves 5 are located one on each side of the principal endless groove 3.

The illustrative machine also comprises a shoe assembly 7 which is located adjacent to the wheel 1. The shoe assembly provides non-rotatable abutments 4 which extend from the shoe assembly 7 into the principal groove 3 and into the secondary grooves 5. The abutments 4 fill the grooves 3 and 5 except for a small clearance to allow rotation of the wheel 1. One of the abutments 4 and the groove 3 define a principal passage through which a first feedstock 30 may be directed into a die assembly 8 of the illustrative machine for extrusion. The other two abutments 8 and the grooves 5 define secondary passages through which a second feedstock 40 may be directed into the die assembly 8 for extrusion about the first feedstock 30.

The die assembly 8 comprises first and second subassemblies which are held within a retaining ring 6.

The retaining ring 6 includes heaters (not shown) to heat the die assembly 8. The first die subassembly is located adjacent to the wheel 1. The first subassembly has a front surface 13, which is closely adjacent to the periphery 2 of the wheel 1, and a rear surface 14 which abuts the second subassembly. The first subassembly also defines a primary passage 9 and two secondary passages 10 extending from the front surface 13 to the rear surface 14. The primary passage 9 meets the front surface 13 to form therein an aperture 21 of generally circular cross-section which communicates with the principal groove 3. The secondary passages 10 meet the front surface 13 to form therein apertures 22 of generally elongate cross-section which communicate, respectively with the secondary grooves 5.

In the operation of the illustrative machine, the first feedstock 30 is fed by conventional means into the principal groove 3 and is forced into the passage 9 through the aperture 21. Simultaneously, the second feedstock 40 is fed by conventional means into the secondary grooves 5 and is forced into the passages 10 through the apertures 22. The primary passage 9, as mentioned above, is initially circular in cross-section, but changes along its length to exit at an aperture 23 formed in the rear surface 14. The aperture 23 is generally rectangular in shape having smoothed corners. Each secondary passage 10 changes along its length from the initial aperture 22 in the front surface 13 and becomes a generally kidney-shaped aperture 24 at the rear surface 14. The primary and secondary passages 9, 10 exit the rear surface 14 at a recessed portion thereof.

The second die subassembly comprises an inner ring 17 and an outer ring 16. The inner ring 17 has a front surface 20, which abuts the rear surface 14 of the first subassembly, and a rear surface 18. A mixing chamber 15 is defined by the recessed portion of the rear surface 14

of the first die subassembly and the front surface 20 of the inner ring of the second die subassembly. The mixing chamber 15 receives material from all the passages 9 and 10 defined by the first subassembly. The inner ring 17 of the second subassembly defines a passage 19 extending from the front surface 20 to the rear surface 18. The passage 19 decreases in cross-section from the front surface to the rear surface. An aperture 25 formed by the passage 19 in the front surface 20 communicates with the mixing chamber 15. The aperture 25 is of similar shape to the aperture 23 formed by the primary passage 9, but is of larger size than that of the aperture 23. The passage 19 forms an aperture 26 in the rear surface 18 of similar shape but of smaller cross-sectional area and of higher aspect ratio than the aperture 23 formed by the passage 9, that is the width of the aperture 26 is very much greater than its height. The aperture 26 provides an extrusion orifice of the illustrative machine. The shapes of the apertures 21, 22, 23, 24, 25 and 26 can be seen in Figure 3.

The illustrative continuous rotary extrusion machine operates in the following manner. A first feedstock 30 passes through the arcuate feed path defined by the principal groove 3 in the wheel 1. The first feedstock 30 may be in the form of a continuous bar, granules, or in powder form delivered by a hopper as is known for prior continuous rotary extrusion machines. As the feedstock reaches the abutment 4, it is diverted into the primary passage 9 of the die assembly 8. Secondary feedstock 40 in the form of, for example wires, is carried in the secondary grooves 5 and is diverted into the secondary passages 10. The primary feedstock 30 takes on the shape of the primary passage and becomes oblate. The two portions of the secondary feedstock 40 similarly take on the shape of the secondary passages 10 and become kidney-shaped in cross-section. The three portions of feedstock 30 and 40 next enter the mixing chamber 15. Hydrostatic pressure keeps

the first and the second feedstocks separate in the shape shown in Figure 4. The feedstock then enters the passage 19 from which it is extruded via the aperture 26 in the rear surface 18 of the second die subassembly, the first and the second feedstocks being extruded simultaneously. The two paths of the second feedstock 40 merge to form a cladding layer about the first feedstock 30 as seen in Figure 5.

In the example shown, the second feedstock is in the form of a wire paid off a spool. However, other means of supply are possible, for example, generating a wire of suitable cross-section on a first continuous rotary extrusion machine and then feeding the wire thus formed directly to a secondary groove of a wheel of a continuous rotary extrusion machine in accordance with the present invention.

The continuous rotary extrusion machine of the present invention allows the cladding of a core by the use of a single wheel.

In the embodiment shown, a relatively thin cladding layer is produced about a central core. It will be understood that to provide a comparatively thick cladding about a core, the relative sizes of the primary and secondary grooves, and the associated feedstock paths will need to be adjusted.

In the embodiment shown, a strip is produced of substantially oblate cross-section. It will be understood that other cross-sectional shapes may be produced by varying the shape of the passages through which the extruded material flows. For example, circular and rectangular cross-sections are among those contemplated.

The formation of a clad feedstock in this manner provides a number of advantages. In particular, this method of production provides a better conformity between the core and the cladding layer. The finished product has improved ductility and is easier to handle and process as a result. Further, the apparatus described allows for simpler press control, and thus flow control, than known tangential methods.

A tape, rod or wire of a given cross-section can be produced by the inventive method, in particular the production of a wire for use in the manufacture of aluminium bodies in which an inoculant is required. At present, for example, an inoculant for aluminium comprises a phosphorous wire of iron or copper phosphide. The production of such a wire may result in the production of phosphene gas which produces a clear danger to health in the production of the wire. Also the phosphorous wire thus produced is somewhat bulky, somewhat brittle and cannot be touched directly by the human hand. There is a danger to health in the handling of the product. The production of flexible tape comprising a copper phosphorous core clad in for example a copper alloy, according to the inventive method provides a lightweight flexible product the surface of which can safely be touched by hand.

CLAIMS

1 A continuous rotary extrusion machine comprising a rotatable wheel, and a die assembly, said wheel having a principal endless groove around its periphery, the machine also comprising a non-rotatable abutment extending into said groove, said abutment and said endless principal groove defining a principal passage through which a first feedstock may be directed into said die assembly for extrusion, wherein said wheel is provided with secondary endless grooves extending around its periphery, and the machine comprises non-rotatable abutments extending into said secondary grooves, said abutments and said secondary grooves defining secondary passages through which a second feedstock may be directed into said die assembly for extrusion about the first feedstock.

2 A continuous rotary extrusion machine according to claim 1, wherein at least one of said secondary grooves is disposed on each side of said primary groove.

3 A continuous rotary extrusion machine according to claim 1 or claim 2, wherein the secondary grooves are each of smaller cross-sectional area than the primary groove.

4 A continuous rotary extrusion machine according to any one of claims 1 to 3, wherein said die assembly comprises a first die subassembly and a second die subassembly, the first and the second subassemblies cooperating in defining a mixing chamber, the first subassembly defining a primary passage extending between an aperture which communicates with the

principal groove in the wheel and an aperture which communicates with said mixing chamber, the first subassembly also defining two secondary passages each of which extends between an aperture which communicates with one of the secondary grooves in the wheel and an aperture which communicates with said mixing chamber, the second subassembly defining a passage which extends between an aperture which communicates with said mixing chamber and an extrusion orifice of the machine.

5 A continuous rotary extrusion machine substantially as described herein with reference to, and as shown in, the accompanying drawings.

6 A method of manufacturing a clad member using a machine according to any one of claims 1 to 5, the method comprising simultaneously feeding a first feedstock to the principal groove of the wheel of the machine and a second feedstock to each of the secondary grooves of said wheel, and simultaneously extruding the first feedstock as a core, and the second feedstock as a cladding on said core.

The Patent Office

Application No:	GB 9811791.4	**Examiner:**	A.R.Martin
Claims searched:	All claims	**Date of search:**	15 July 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): B3P

Int Cl (Ed.6): B21C 23/00

Other: On line databases WPI,EDOC,JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y	GB1566152	UKAEA see claim 1	Claim 1 at least
A	GB1584131	Hitachi see claim 1	"
Y	US4564347 A	Babcock see claim 1	"
A	US 4217852 A	Hitachi see claim 1	"
A	US4242368 A	Hitachi see claim 1	"

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.